

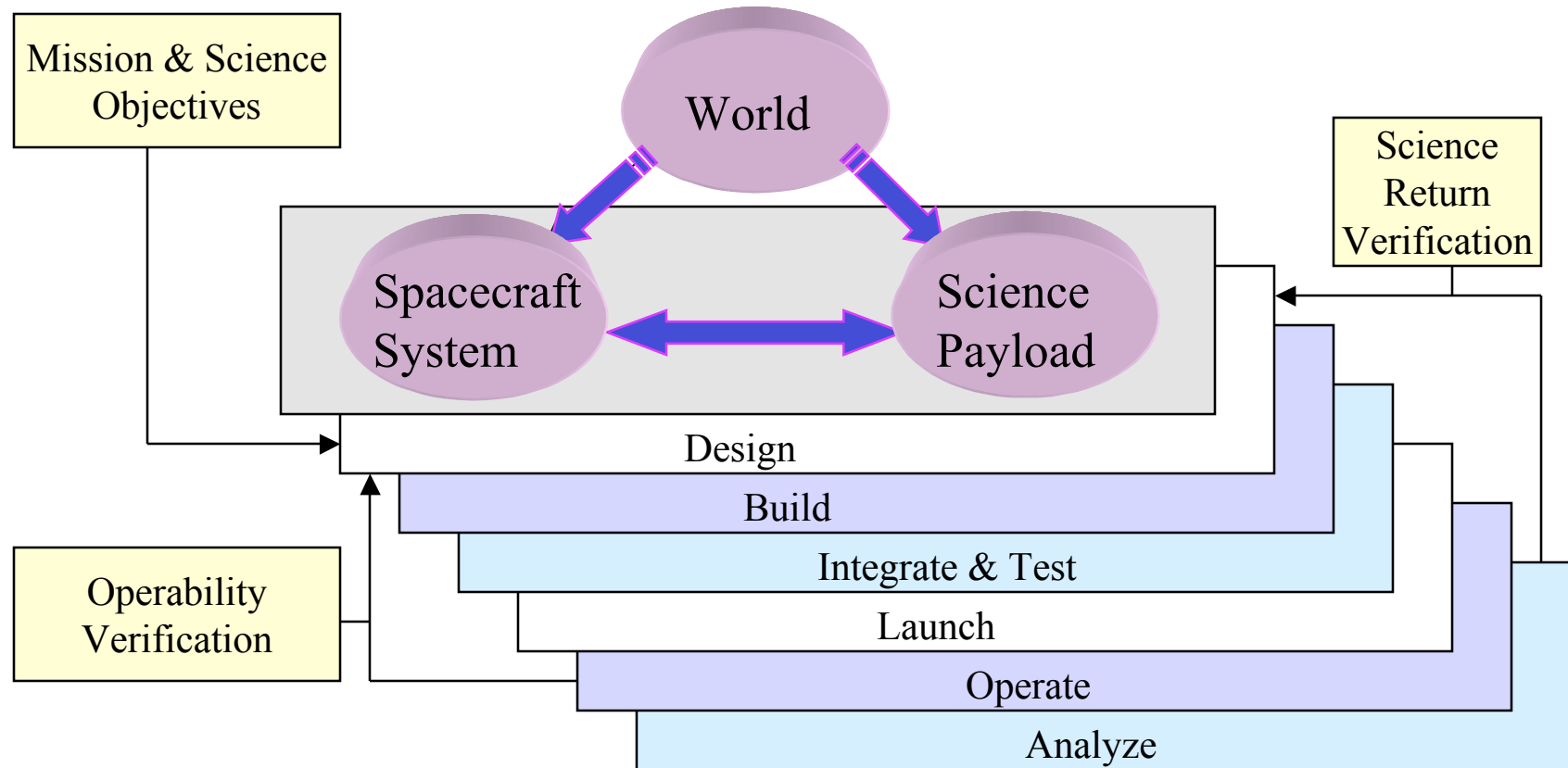


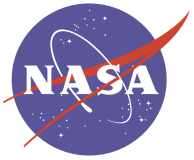
## Design, Operate, then Build?

Meemong Lee, Richard Weidner, Shin-Ywan Wang  
Mission Simulation and Instrument Modeling Group

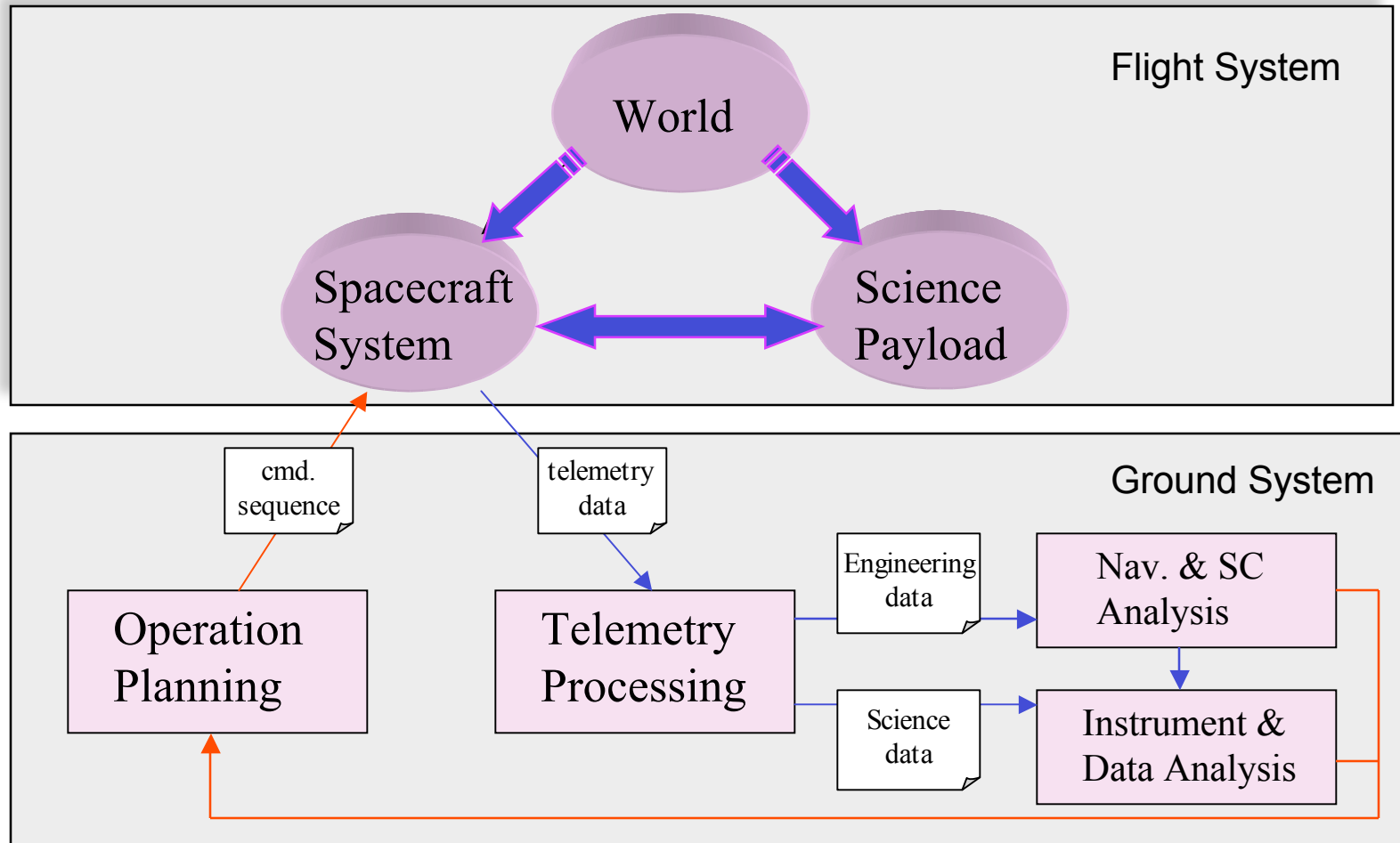


# Mission Lifecycle





# Mission Operation & Analysis

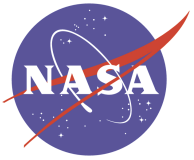




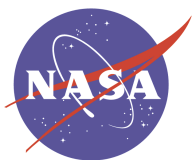
## Challenges



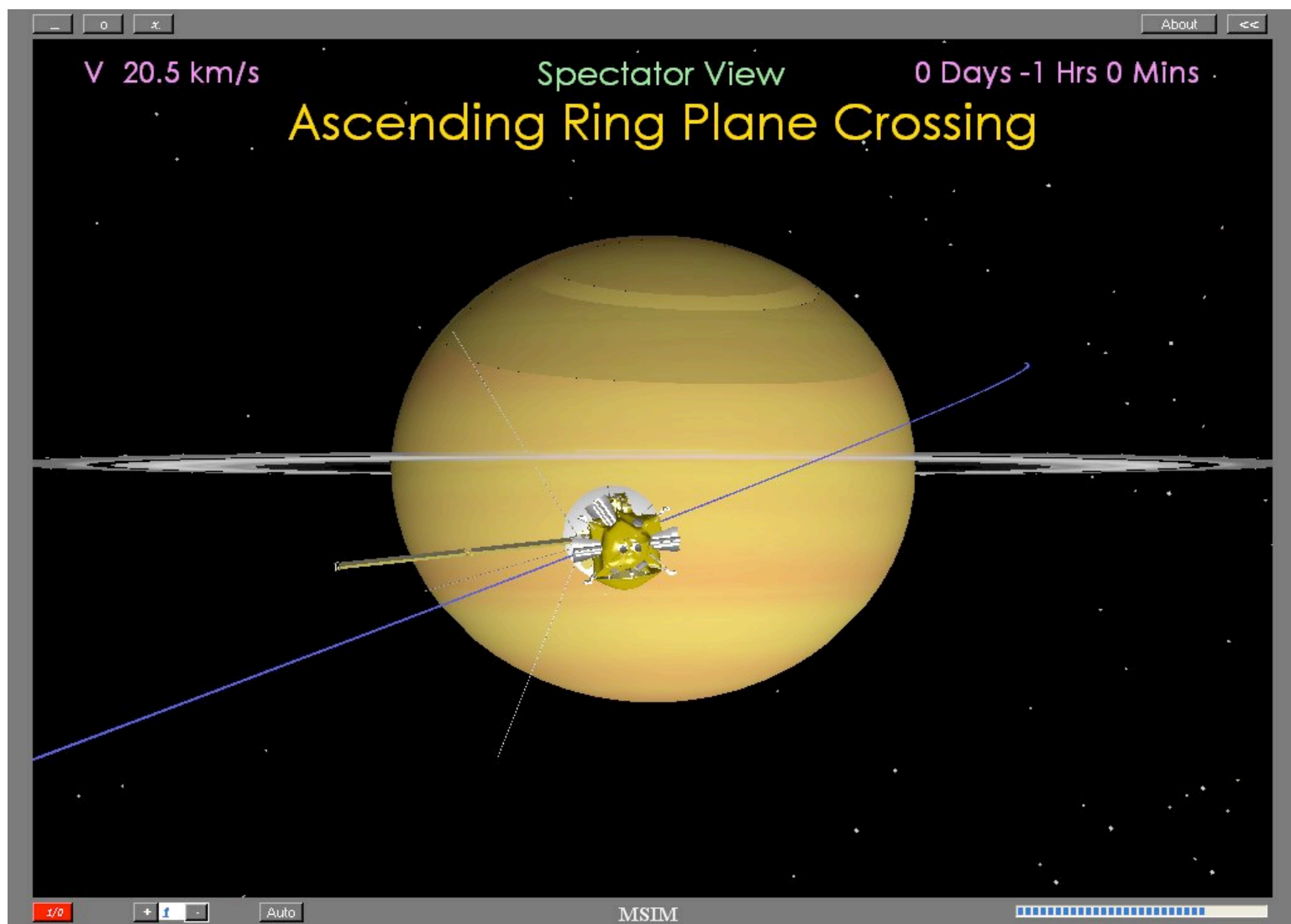
- How to share accurate understanding of operation objectives among all mission teams?
- How to develop operation sequences from operation objectives?
- How to validate operability of a system before it is built?
- How to verify science-return before receiving telemetry?
- How to progressively transition into real mission operation phase?



## Sharing Operation Objectives

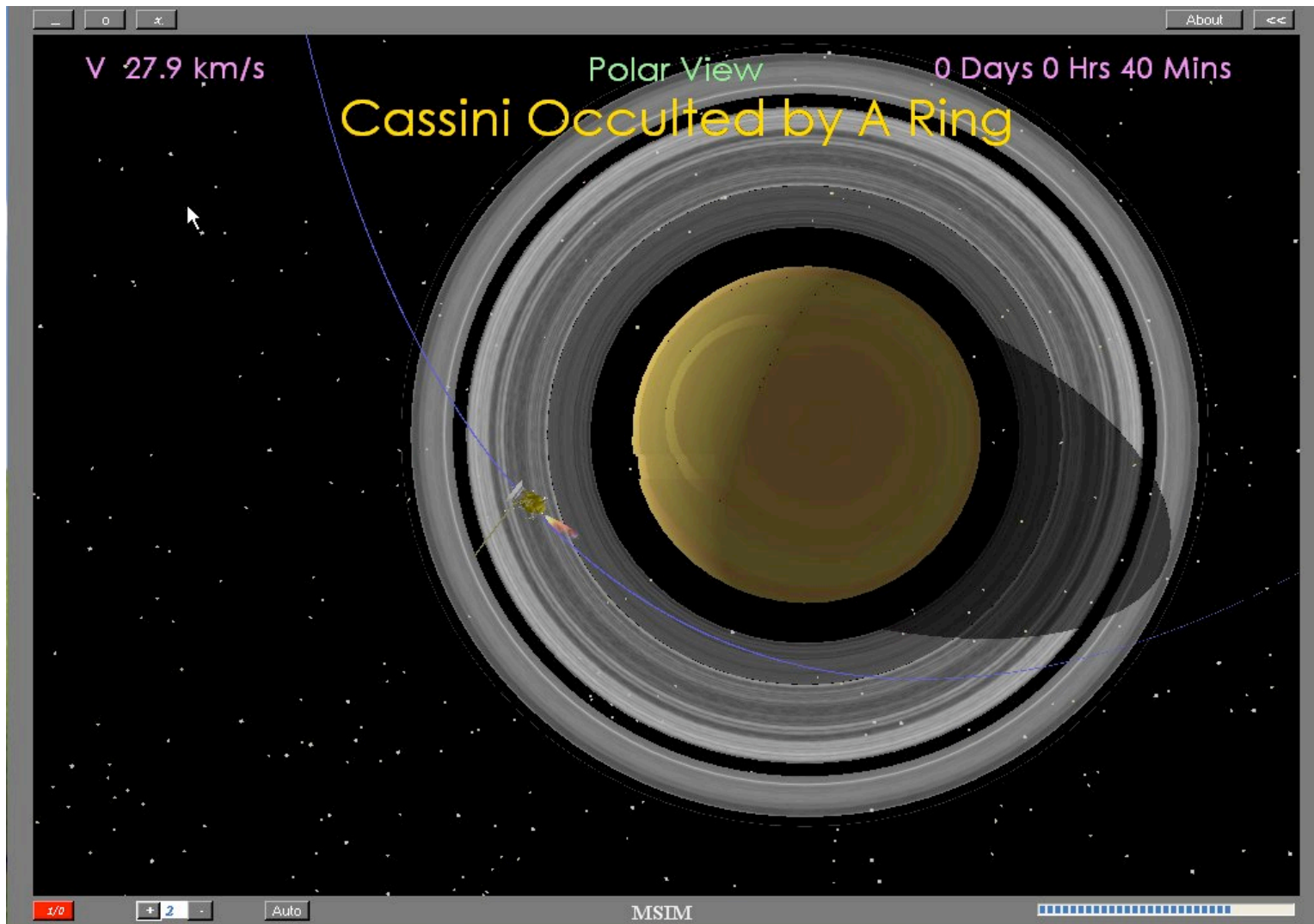


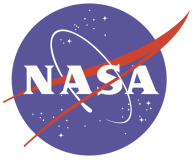
# Cassini-Saturn Orbit Insertion



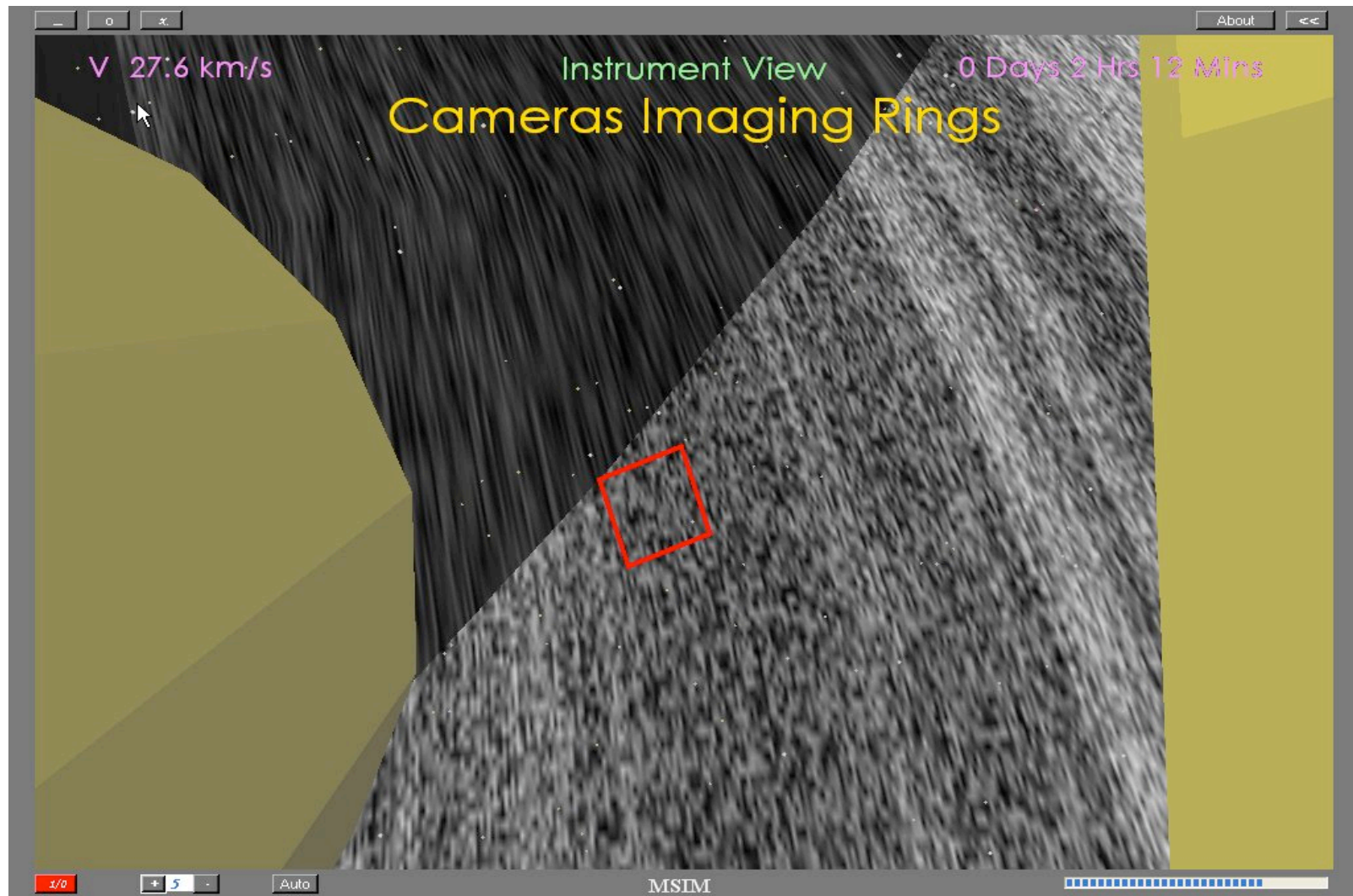


# Cassini-Saturn Orbit Insertion





# Cassini-Saturn Orbit Insertion



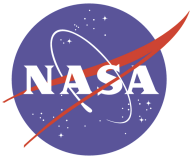




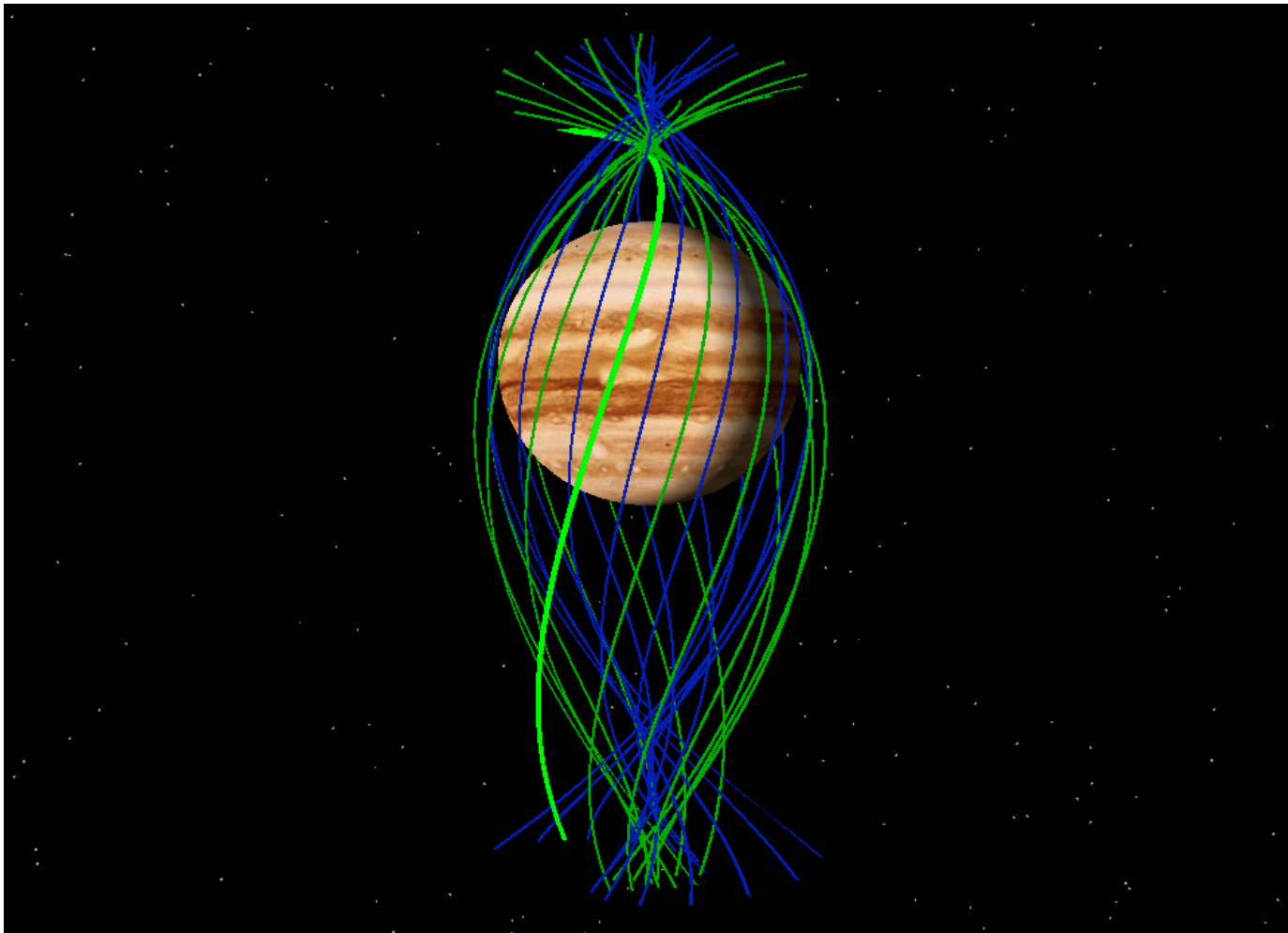
## MSVN-Cassini

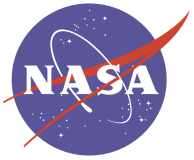


- 8 Hour Long SOI Operation
- Second-level System State Simulation
- Five Simultaneous Viewing Channels
  - Trajectory
  - Attitude Control
  - High Gain Antenna
  - Imaging Camera
  - Data Downlink
- Synchronized SOI event broadcasting
  - Flight Operation Center
  - Cassini Mission Teams & Families
  - Press Room
  - General Public



## Juno Mission Concept



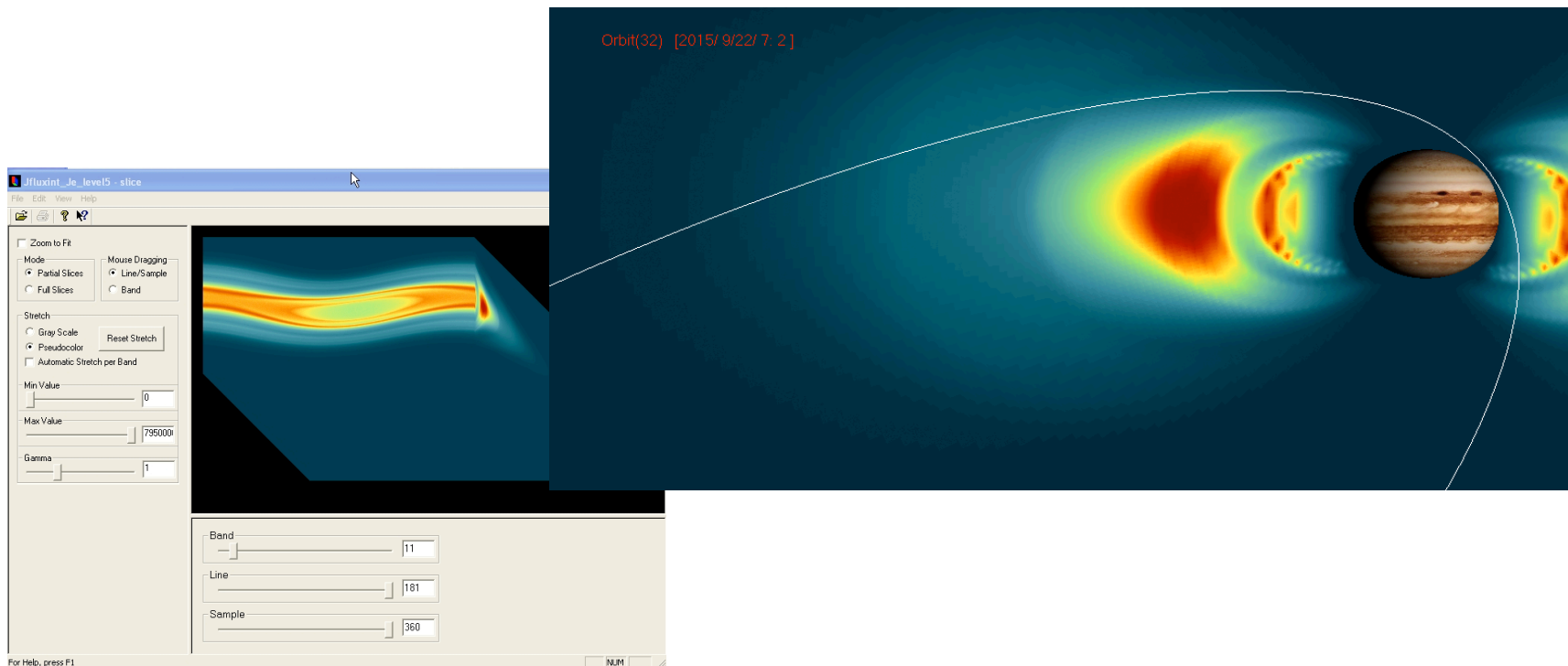


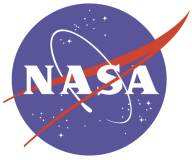
# Juno Mission Concept



## Jupiter Radiation Field

- Longitudinal Variation
- Orbit Trajectory and Planet Rotation
- Spacecraft Shielding and Trajectory Design

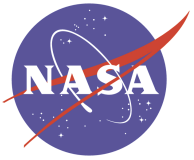




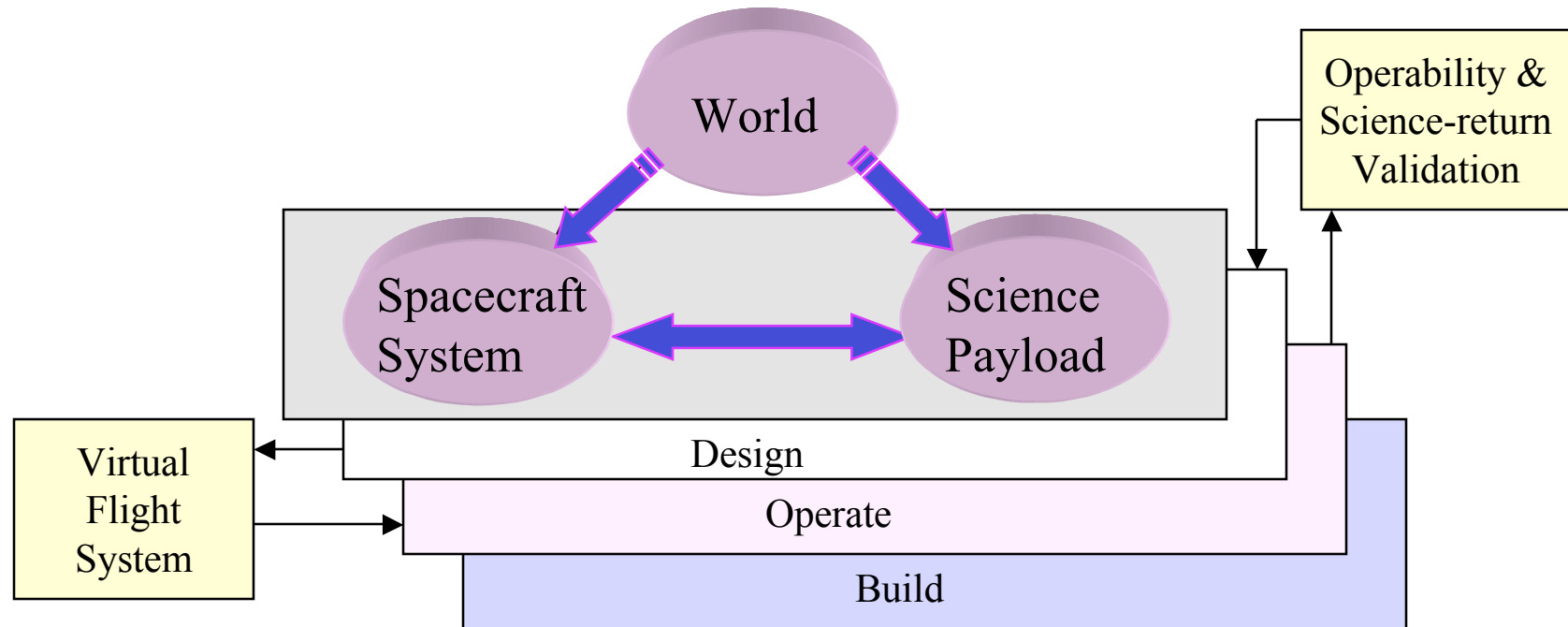
## MSVN-JUNO



- Multi-year Mission Operation
- 33 Orbits (11 day orbit)
- 6 hour long science period (+/- Peri-Jov)
- Multiple Perspectives
  - Trajectory
  - Attitude Control (Spinning spacecraft)
  - Solar Panel (Power)
  - HGA (Telecom)
  - 6 instruments with various FOVs
- Distributed Mission Teams
  - SWI - PI
  - LMA - Spacecraft
  - Various Instrument Developers (International)

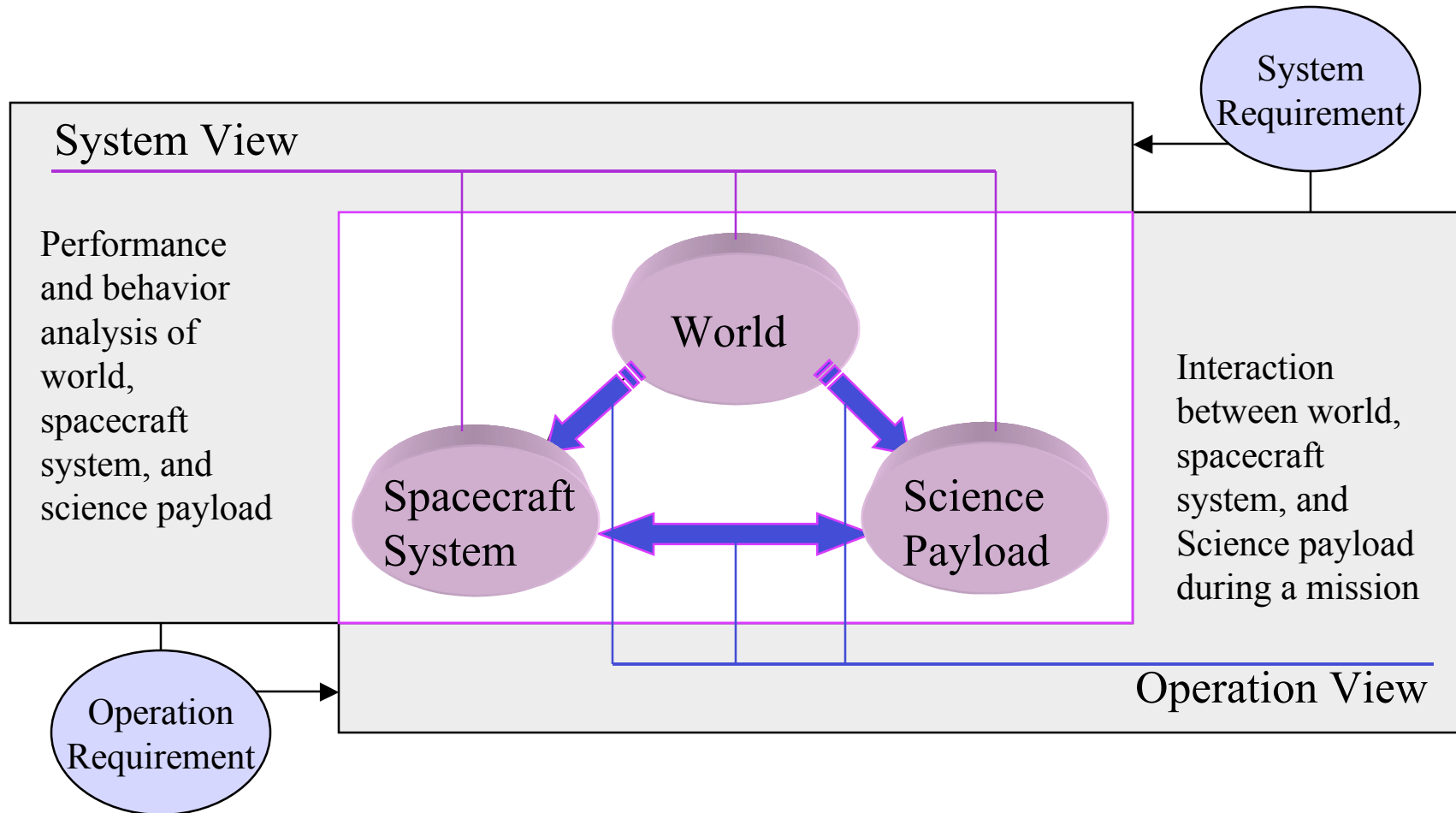


# Design Validation & Verification



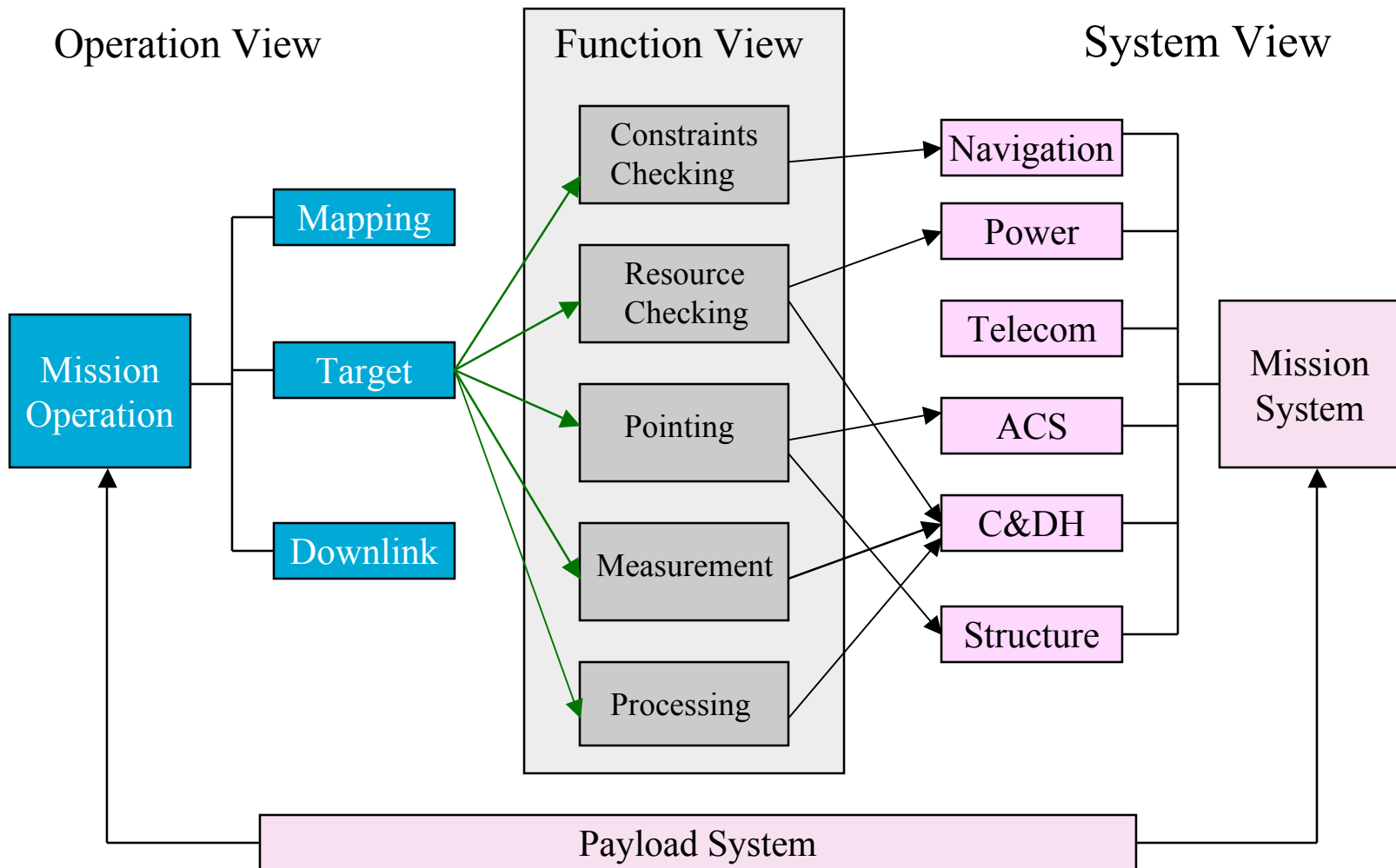


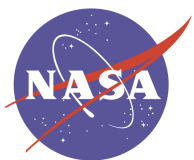
# Design Validation & Verification



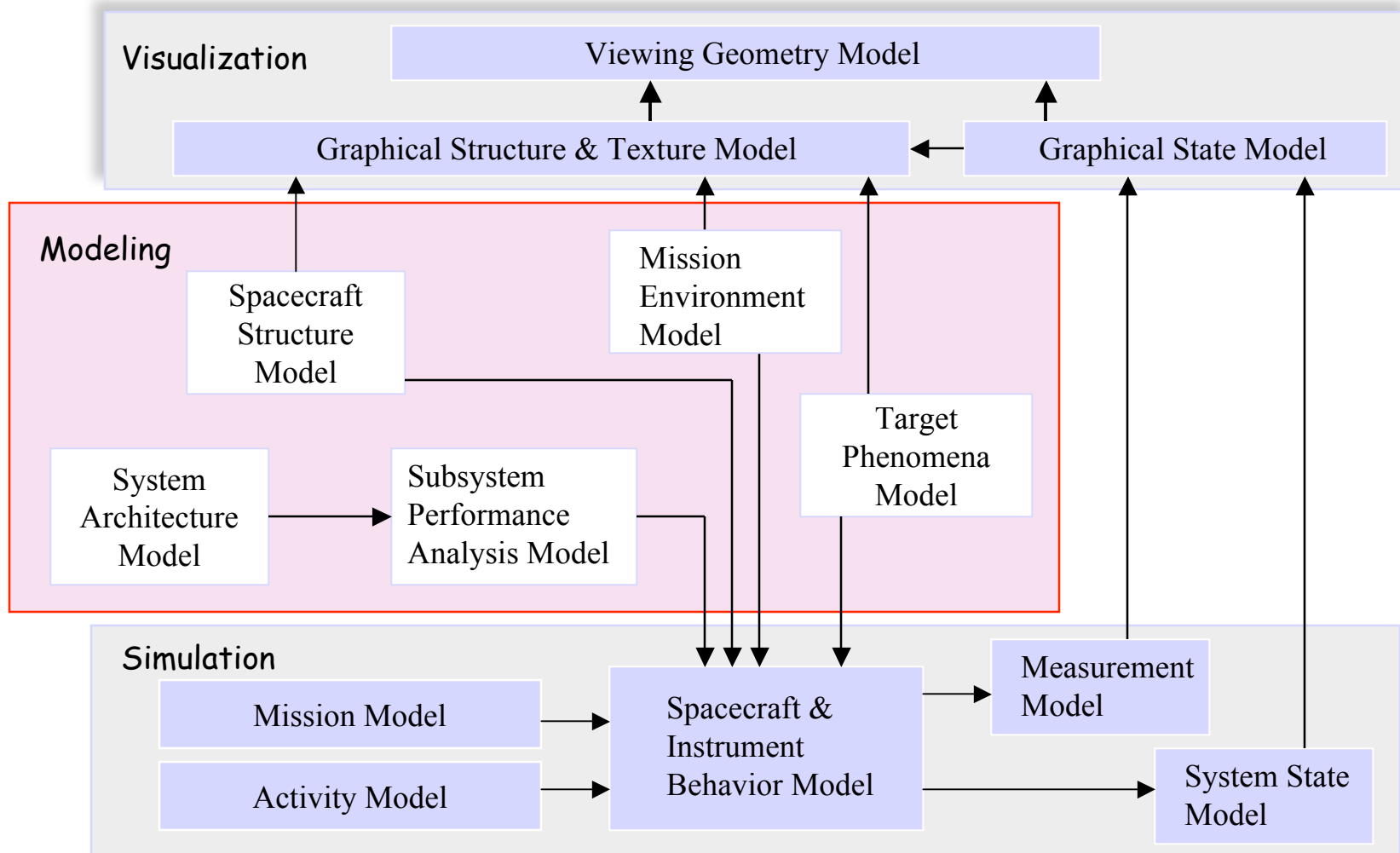


# Operation Sequence Generation





# Modeling, Simulation & Visualization







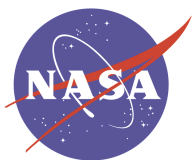
# Virtual Mission Operation Framework



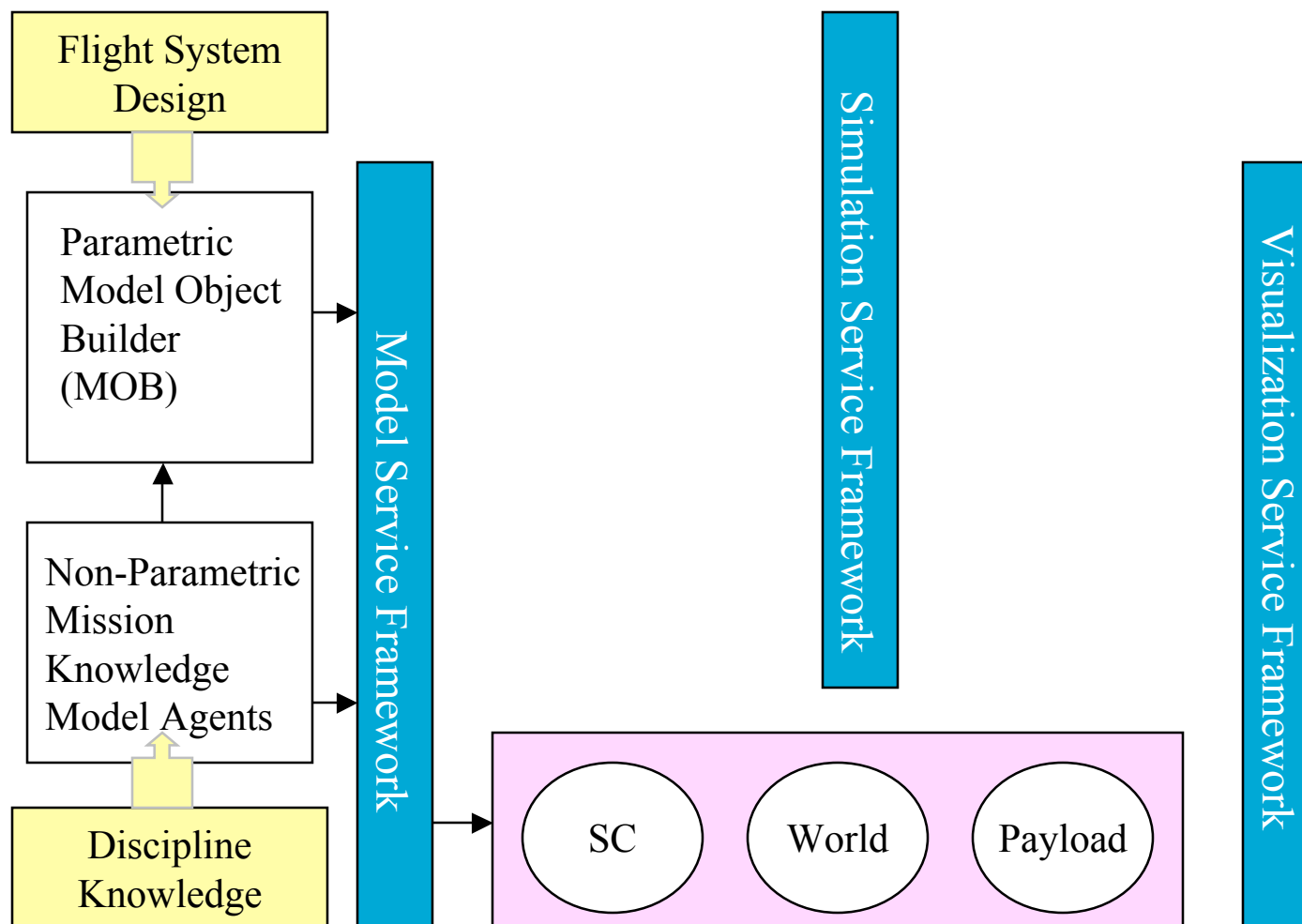
Model Service Framework

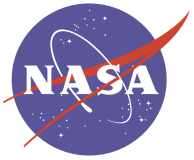
Simulation Service Framework

Visualization Service Framework

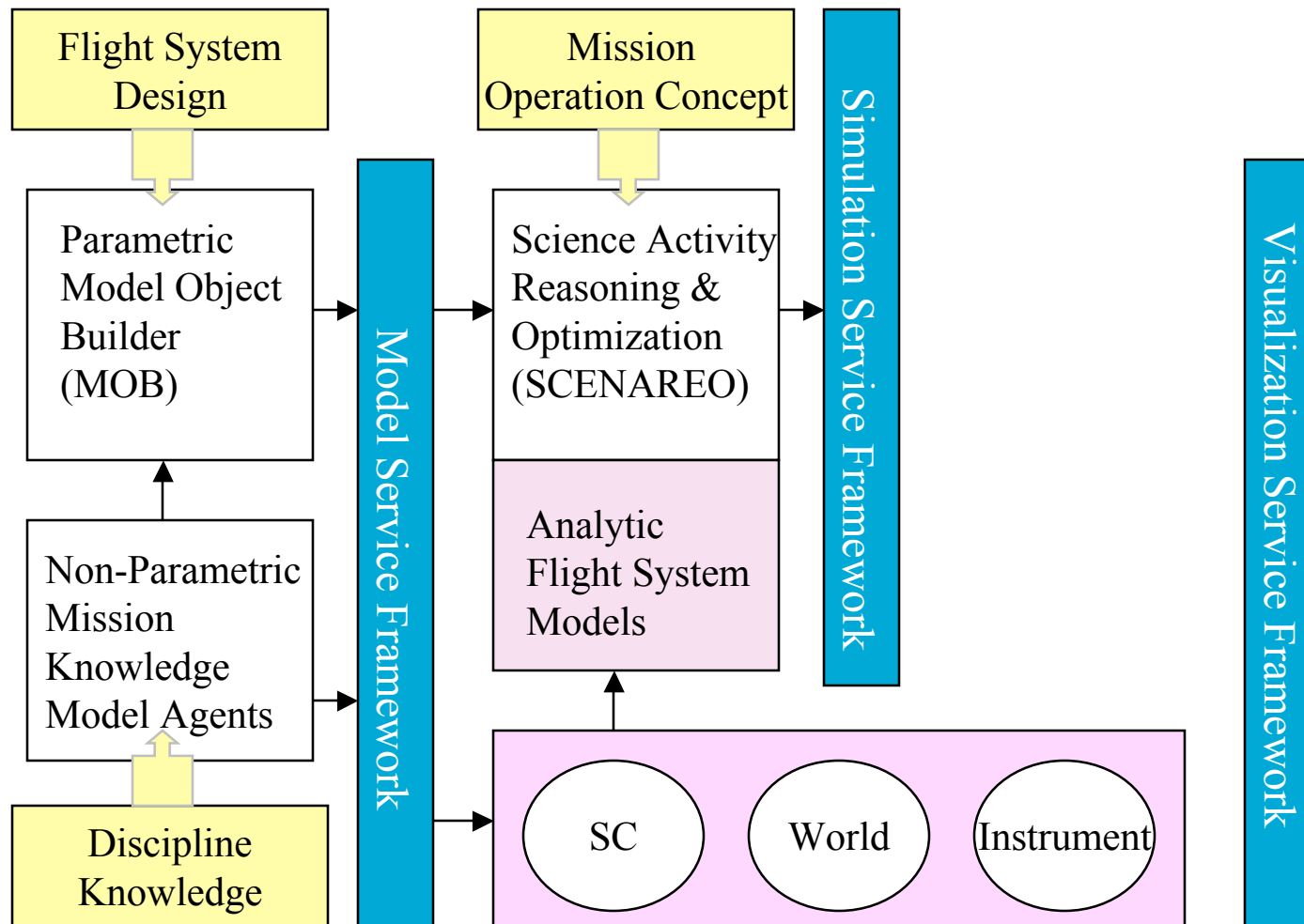


# Virtual Mission Operation Framework



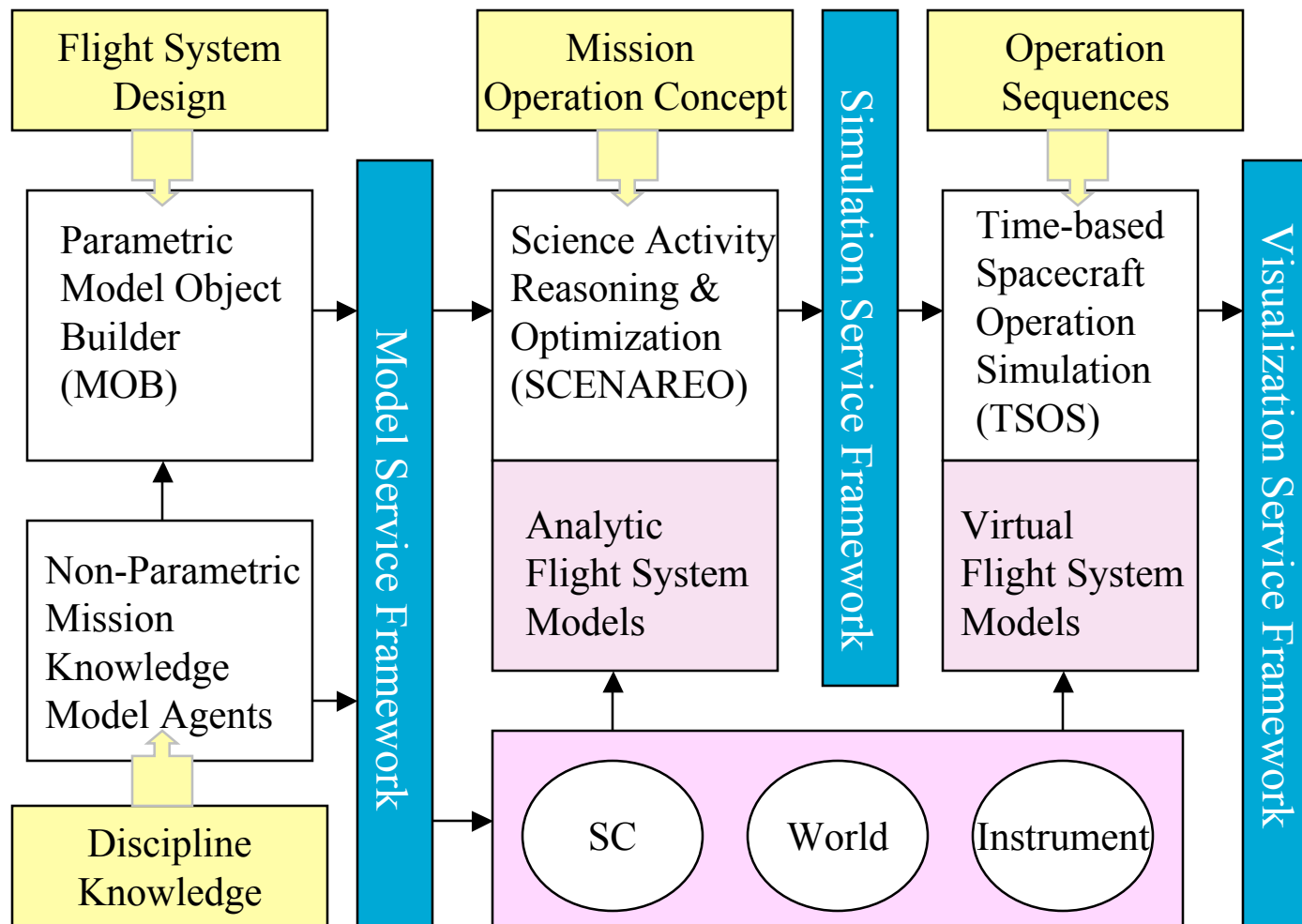


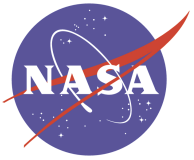
# Virtual Mission Operation Framework



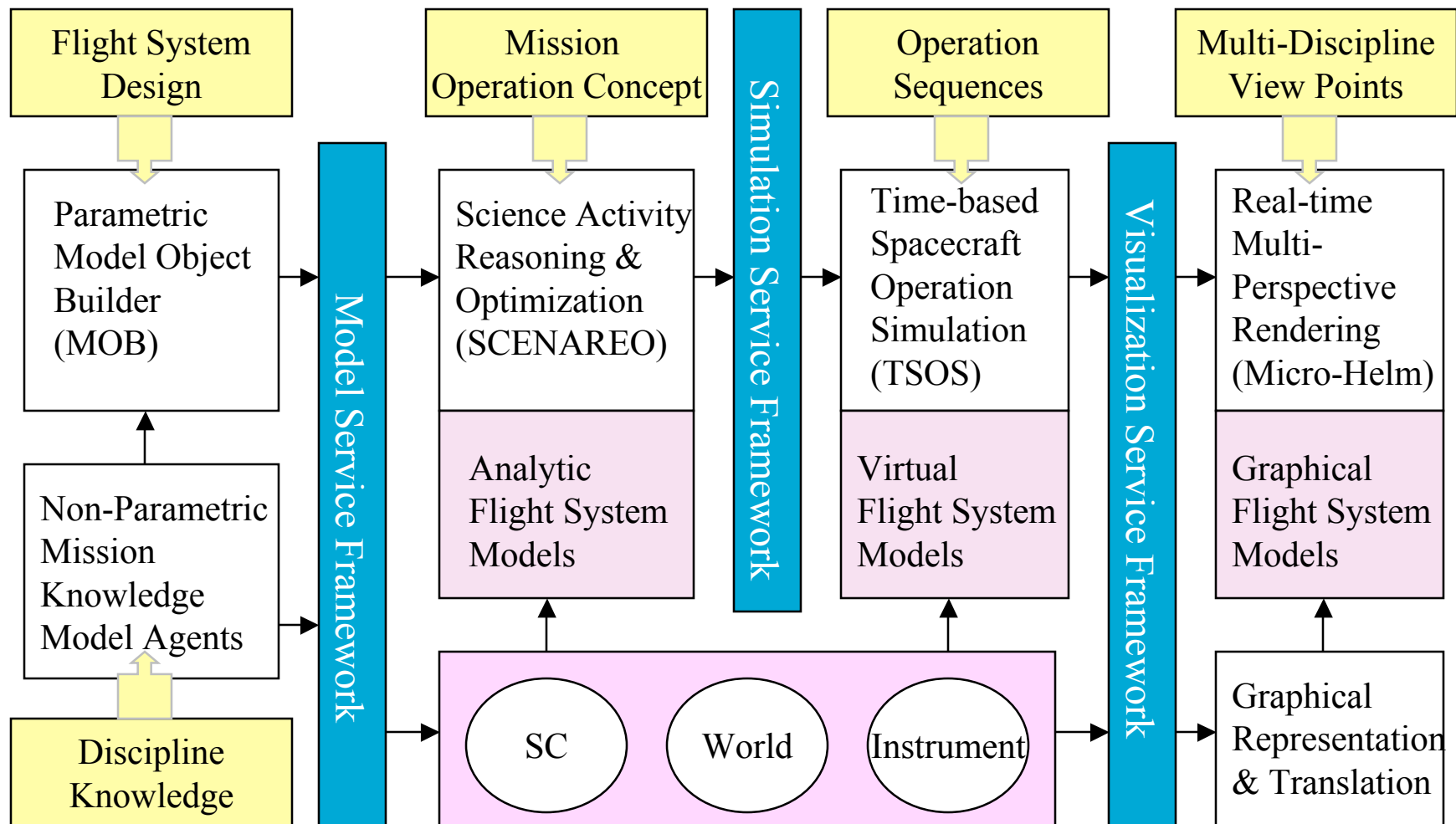


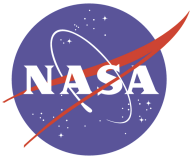
# Virtual Mission Operation Framework



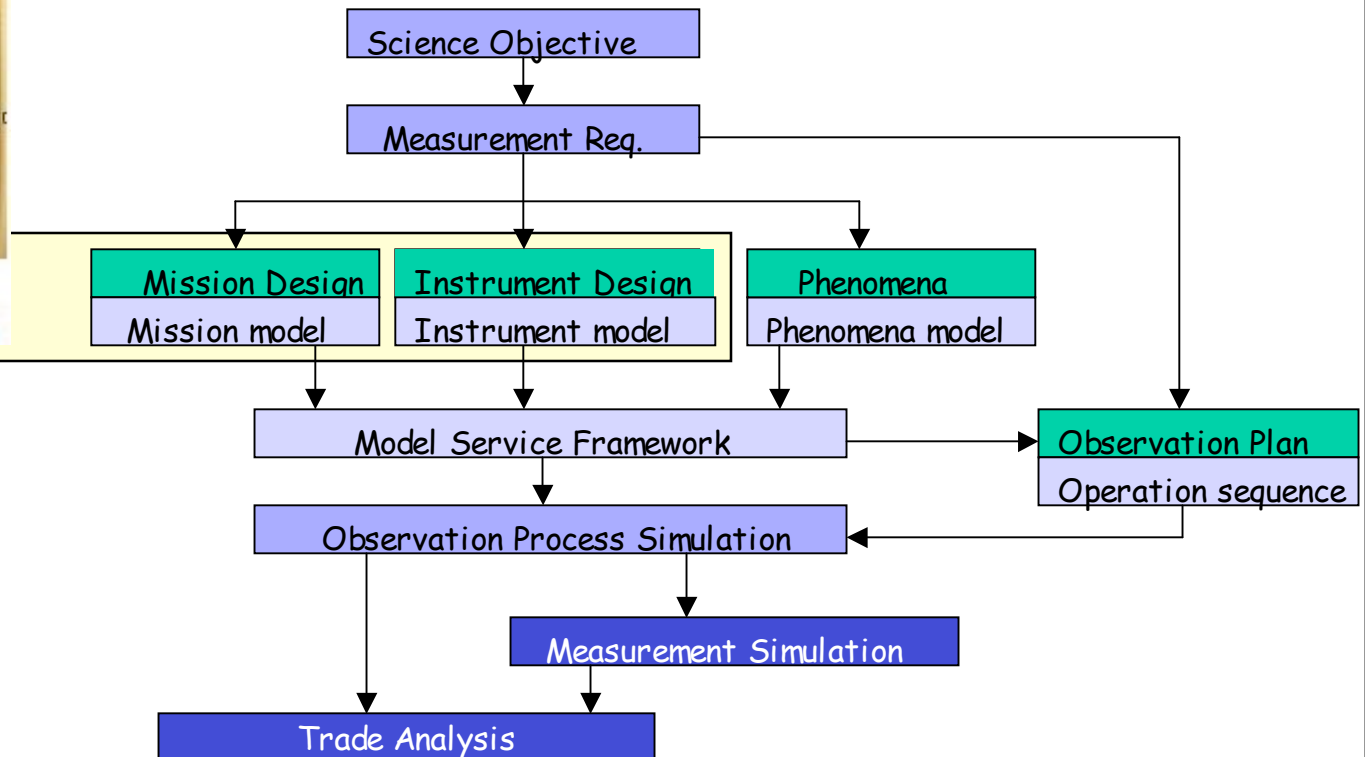


# Virtual Mission Operation Framework

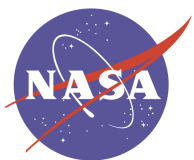




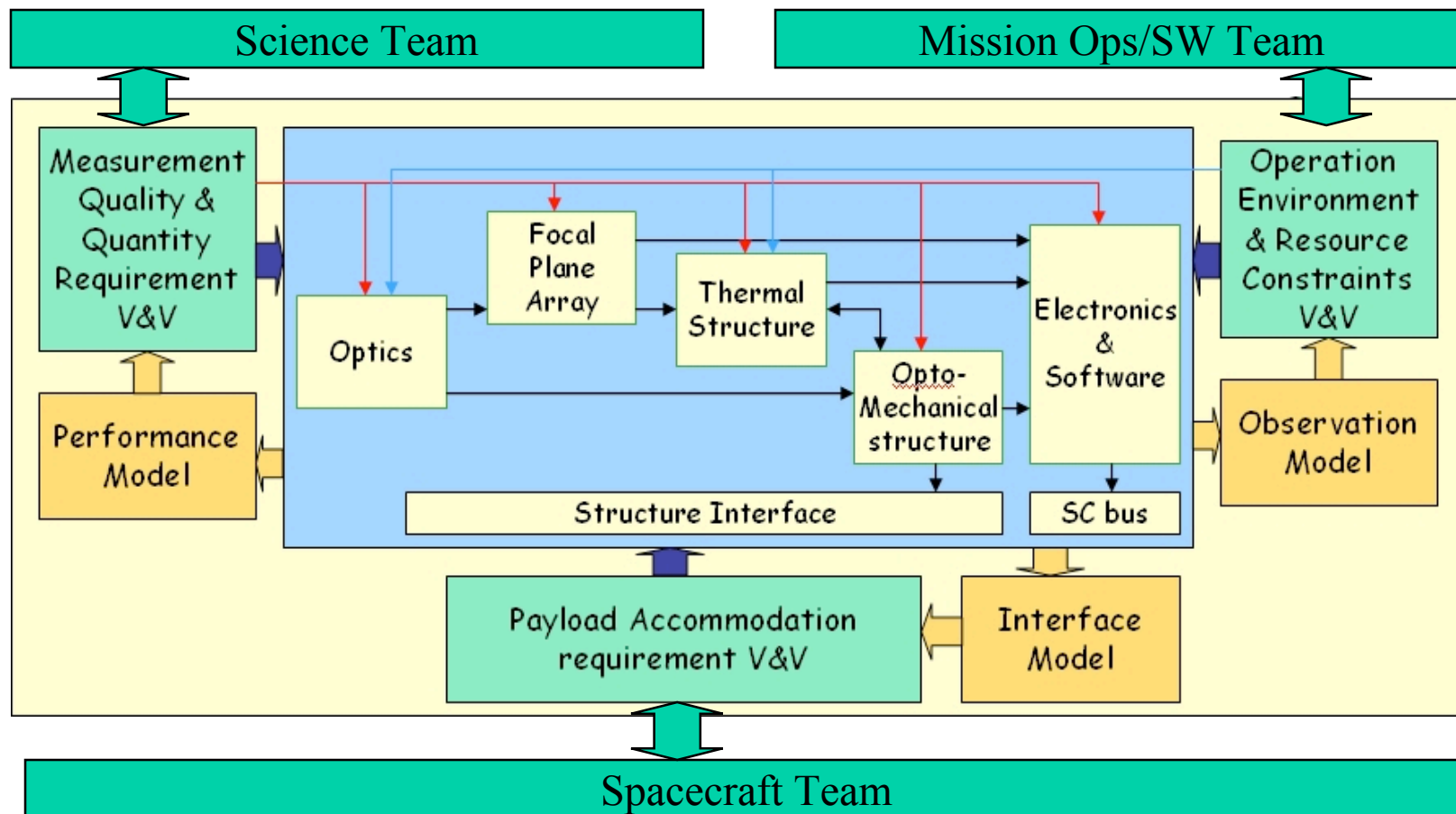
# Mission Concept Study



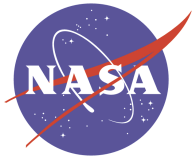




# Instrument Design Exploration







## Benefits



**Intelligent Design space Exploration** : Coherent subsystem model exchange mechanism allows efficient analysis of multi-dimensional design trades.

**Lifecycle-continuous M&S Evolution** : mission system compatible model hierarchy and lifecycle-phase compatible model types allows flexible adaptation to lifecycle-wide engineering needs

**Improved Science-Return** : Design-time operability and science-return validation fosters operation and science-friendly system design and prevents “too-late” discovery of design defects.



## Acknowledgement



- ESTO High Performance Computing – Robert Ferraro
- JPL R&TD – Eric Antonssen
- ESMD-Simulation Based Acquisition – Don Monell